NASA AEROSPACE SAFETY ADVISORY PANEL
National Aeronautics and Space Administration
Washington, DC 20546
VADM Joseph W. Dyer USN (Ret.), Chair

March 16, 2010

Major General Charles F. Bolden, Jr.
Administrator
National Aeronautics and Space Administration
Washington, DC 20546

Dear Gen. Bolden:

The Aerospace Safety Advisory Panel held its First 2010 Quarterly Meeting at the Marshall Space Flight Center (MSFC) on February 23-24, 2010. We greatly appreciate the participation and support received from MSFC subject matter experts and support staff.

The Panel submits the enclosed Recommendations with Minutes resulting from this meeting for your consideration.

Sincerely,

Joseph W. Dyer, VADM, USN (Ret.)
Chair

Enclosure

ASAP RECOMMENDATIONS, FIRST QUARTER 2010

2010-01-01: Research and Development of S&MA Tools

Finding: For years, the aerospace world has been using the same fault-tree analyses, risk matrix assessments, preliminary hazard analyses, etc., that were developed in the Apollo era to identify and assess hazards and risks. There has rarely been enough time or funds to develop the new tools needed to identify and control hazards inherent in modern technologies such as software, firmware, and robotics, to name a few. A potential NASA shift away from Program support to technology development may provide an opportunity to develop the tools needed to ensure the safety of these modern technologies.

Recommendation: NASA should develop a process to ensure that technical safety tool development is identified as a priority when technology development opportunities are being evaluated for future funding.

Rationale: As the approach of NASA changes to develop the technologies to take us to Mars and further beyond, technical safety tool development is just as important as the new engines and the new computers that will be needed. This also presents an opportunity to use NASA's talented personnel to solve tomorrow's problems. Tool development will open up the trade space even further and provide NASA the ability to understand and control the risks of state of the art technologies it will be using.

2010-01-02: S&MA Technical Excellence Program (STEP)

Finding: NASA has an excellent process—STEP—to improve the knowledge base and professionalism of the S&MA workforce. The ASAP is impressed with the program that went from concept, to actual practice, to having over 700 graduates in STEP level 1 in one year.

Recommendation: The NASA Safety Center (NSC) should continue to develop the remaining STEP levels (levels 2-4) for S&MA, and the NSC, in the process of doing this development, should take into account the changing nature of the S&MA roles within the new NASA organization; in essence, develop STEP for future roles, not past roles.

Rationale: NASA needs to develop the current S&MA curriculum for those jobs that will remain. In the new NASA, however, the work of the S&MA professional will change. The STEP process will need to lead this change with timely development of all S&MA personnel that will be affected by this shift in job responsibilities.

2010-01-03: S&MA Analyze Changing Work and Skills Needed for the Future

Finding: NASA's work in human space flight will be changing with the new FY 2011 budget. S&MA work will also change, and new skills (or a different mix of skills) will be needed.

Recommendation: NASA S&MA should take a leadership role in beginning to analyze how the S&MA work is going to change, and what kinds of skills are going to be needed in the future.

Rationale: As the new NASA direction becomes clearer, the S&MA organization should identify the skills, technologies, knowledge and experiences that will be required of the S&MA professional of the future. One example may be how the S&MA organization will verify that the commercial LEO providers support strong safety.

2010-01-04: Integration of Crew Requirements into Design

Finding: Ares thrust oscillation design changes have been largely driven by an understood need to limit exposure of the crew to certain vibration levels. To the Panel's knowledge, the underpinnings for these assumed vibration limits have not been rigorously explored. Given the potential for human vibration limits to drive future designs, more research needs to be done on acceptable vibration levels for the crew. Additionally, the difficulties the Panel observed in identifying, validating, and integrating the crew's desires and needs with regard to vibration for Ares 1 points out a need for improvement in the overall process for crew input to system requirements.

Recommendation:

A) Research be initiated to establish and codify crew vibration limits for various phases of flight for future space vehicles.
B) Develop and incorporate into the design process a more rigorous process for indentifying, assessing, resolving, and integrating the crew's desires and needs into the system design requirements for future vehicles.

Rationale:

A) It is important that vibration requirements that drive design be properly researched and validated so that unnecessary costs are not incurred and design and development schedules are not unduly impacted, while fully meeting crew safety needs.
B) It is also critical that a standard method be implemented for properly weighing and implementing the entire class of crew-driven requirements.

2010-01-05: Acquisition Strategy and Timeline for Development and Publication of Human Rating Requirements (HRR) for Commercial Activities.

Finding: The HRR issue has been a long running open ended item, and the ASAP is disappointed on the timetable that NASA has thus far demonstrated. The ASAP understands the complexity and difficulty of development of human rating (HR) standards for the commercial realm. The ASAP heard recently that there now must be an acquisition strategy that parallels or precedes the standards. There is no question that an acquisition strategy is fundamental to the development of standards, but NASA should not stop or slow efforts to continue to develop the HR processes that have begun. NASA has issued a statement that before the end of 2010, there will be a promulgation of the HRR for commercial activities. This timetable has the potential to put NASA behind in guiding systems currently under development, rather than ahead.

Recommendation: NASA should taken action immediately to develop the acquisition strategy to guide the development of the HR process. The ASAP continues its long standing recommendation that NASA develop the HR process for the commercial sector. The ASAP also recommends a more aggressive timeline for the development and publication of commercially related human requirements.

Rationale: The President's FY2011 Budget Request contains the following direction: "The budget funds NASA to contract with industry to provide astronaut transportation to the International Space Station as soon as possible, reducing the risk of relying solely on foreign crew transport for years to come. A strengthened U.S. commercial space industry will bring needed competition, act as a catalyst for the development of other new businesses capitalizing on the affordable access to space, help create thousands of new jobs, and help reduce the cost of human access to space." This is clear general guidance, but it is important to have an acquisition strategy on how to accomplish this direction as well as a HR process for the commercial sector.

2010-01-06: Knowledge Capture and Management

Finding: The FY 2011 President's Budget Request cancels the Constellation Program. There is a wealth of knowledge and lessons-learned during the Program design, development, and test activities.

Recommendation: With the dismantlement of the Constellation program, the panel recommends that NASA begin now to fund and to document the tacit knowledge and to organize the already documented explicit knowledge that has been learned and developed to date. This knowledge can be organized into packages for ease of use.

Rationale: Much of the knowledge and lessons learned can be applied to future space flight vehicle developments, whether they are commercial or not.

2010-01-07: Methodology for Performing Integrated Abort Risk Analysis and Development of Supporting Tools

Finding: Integrated abort risk analysis and assessment are required for the proper design of crew survivability methods. This presents a challenge to launch vehicle providers who need to design for safe human flight and provide evidence of satisfactory accomplishment.

Recommendation: NASA should prescribe the methodology for performing integrated abort risk analysis and develop the supporting tools as needed so that these types of analyses are performed uniformly across the industry. This guidance could be developed as a stand-alone guidance document and be referenced in the HR criteria.

Rationale: Properly designed abort triggers, including measurements to provide for abort triggering and the requisite timing of the abort triggers, are needed to ensure the safety of the crew. The ASAP feels that the industry as a whole could benefit from having guidance in this area, and that this in turn will facilitate NASA's insight and oversight activities to validate proper performance of this analyses when applied to NASA-crewed flights.

2010-01-08: Leading Indicators for Industrial Safety

Finding: MSFC has an exceptionally strong industrial safety program and the SM&A organization is to be commended for their efforts to achieve even better results. One area worth further investigation is improving on the set of leading indicators that are used to gauge the potential for mishap occurrence.

Recommendation: The MSFC S&MA organization should spend some time looking at leading indicators that other industries and organizations are using. In particular, the chemical process industry is a source that may be helpful.

Rationale: In looking at the leading indicators and efforts that one considers putting into place to make things better, one can ask: Do we have the right set? Investigation into what is being used in other organizations could help answer this question.

AEROSPACE SAFETY ADVISORY PANEL
2010 First Quarterly Report
Minutes and Recommendations

Aerospace Safety Advisory Panel (ASAP)
Public Meeting
February 24, 2010
Marshall Space Flight Center
Huntsville, AL

ASAP Members Present
Vice Admiral Joseph W. Dyer, USN (Retired), Chair
Mr. John C. Frost
Ms. Deborah Grubbe, P.E.
Mr. John C. Marshall
Ms. Joyce A. McDevitt, P.E.
Dr. Donald McErlean
Dr. George Nield

ASAP Staff and Support Personnel Present
Ms. Katherine Dakon, ASAP Executive Director
Ms. Susan Burch, ASAP Administrative Officer
Ms. Paula Burnett Frankel, Reports Editor

Attendees, Public Session
Sid Bourgeois, Northrop Grumman
Don Hozoer, NASA/MSFC
Tony Lyons, NASA/MSFC
Vicki Wade, Bastion Tech.
Donovan Mathias, NASA/ARC
Corky Clinton, NASA/MSFC
Twila Schneider, NASA/MSFC
Robin Henderson, NASA/MSFC
Dan Dumbacker, NASA/MSFC
Herb Shivers, NASA/MSFC
Pat Fuller, NASA/MSFC
Jim Frank, Tansi Associates
Chris Cianciola, NASA/MSFC
Troy Zigler, NASA OIG
Tammy Knight, CS30
Roy Malone, NASA/MSFC
Sherry Jennings, NASA/MSFC
Dave Cockrell, NASA/MSFC
Teresa Van Hooser, NASA/MSFC
Jeff Irons, Ironsclad Solutions, Inc.
Daryl Woods, NASA/MSFC

OPENING REMARKS

The Aerospace Safety Advisory Panel (ASAP) held the public session of its first 2010 quarterly meeting at the Marshall Space Flight Center (MSFC), Huntsville, Alabama.

Admiral Joseph Dyer, Chair of the ASAP, called the meeting to order at 12:30 p.m. He began by relating the dialogue the ASAP had with Mr. Robert Lightfoot, Director of MSFC, the previous day. He expressed the Panel members' confidence in Mr. Lightfoot's leadership and their appreciation for the Center's hospitality. MSFC, one of the largest and most diverse NASA Centers, is responsible for Space Shuttle propulsion, payload operations, and for the design and development of America's next generation launch vehicles, specifically Ares I and Ares V. The Center accomplishes these tasks with some 2500 civil servants and 3500 contractor support. NASA is at a transition point between its previous course and its new course as expressed in the FY 2011 President's Budget Request. There is an understandable uncertainty and some disquiet as the details of the new course are yet to take shape. It is the ASAP's hope and expectation that more detailed explanation and planning being developed at NASA Headquarters be

made available as soon as possible to MSFC and the other Centers impacted by the change in direction. Thus far, the promulgation of a clearly understood path forward has yet to reach the Centers.

MSFC's leadership is clearly focused on the safety of the four remaining Space Shuttle missions, which is perhaps the Nation's most important work with regard to space safety. The efforts to keep rigor and attention to detail all the way through the completion of the last flight include an aggressive communications outreach policy from the Center Director and other levels of senior management to help people stay focused on the task at hand. Nevertheless, the issue of job security remains a concern by most Marshall employees and has the potential for causing distractions from the critical job at hand.

Understanding the Human Spaceflight (HSF) acquisition strategy going forward is one of the challenges that was discussed during the ASAP's meetings. "Acquisition strategy" includes an understanding of what is being procured, what type of contract will be used, how competition is going to be interjected, how oversight and insight will be part of the plan, how the product will be certified, and how the bona fides of the contract will be met. The ASAP would not expect all of this work to be accomplished quickly, but for safety and the well-being of the workforce, the Panel emphasizes the necessity of developing and promulgating a good acquisition strategy as quickly as possible.

Adm. Dyer noted a paragraph from the FY 2011 budget direction as it relates to NASA: "The budget funds NASA to contract with industry to provide astronaut transportation to the International Space Station as soon as possible, reducing the risk of relying solely on foreign crew transport for years to come. A strengthened U.S. commercial space industry will bring needed competition, act as a catalyst for the development of other new businesses capitalizing on the affordable access to space, help create thousands of new jobs, and help reduce the cost of human access to space." While he opined that this is the beginnings of transition guidance, he reinforced that an acquisition strategy to accomplish this direction is fundamental and needed quickly.

The ASAP's detailed discussions with MSFC personnel included many areas: safety and mission assurance; engineering, including how Technical Authority (TA) is accomplished at MSFC; and the status of Ares 1 and Ares V. Human Rating Requirements (HRR) is a focus subject for the ASAP, and the Panel addressed that subject, noting both progress and work to be done. One of the real successes over the past couple of years has been taking Technical Authority from a "fuzzy" concept to one that is now well understood and well executed. Conversely, the FY 2010 appropriation legislation directs continued work on the program of record, and while that continues at MSFC, implications of the impending change have again introduced fuzz back into the equation.

Adm. Dyer noted that Dr. Jim Bagian, who was present during the MSFC deliberations, had to depart before the public meeting but his comments would be relayed by other Panel members. He welcomed the new ASAP member, Dr. George Nield, who is the Associate Administrator for the Office of Commercial Space Transportation at the Federal Aviation Administration (FAA). There is much important interagency work to be done between NASA and FAA as we look at how to build and certify an acceptable space transportation system.

Mr. Marshall added that the budget statement that was read by Adm. Dyer has been useful in ASAP deliberations on the issue of utilization of commercial resources. ASAP has been encouraging NASA to continue to more fully develop the Human Rating (HR) standards for potential NASA-crewed commercial launches. It is important to clarify that the ASAP has never taken a position on whether space transportation should be an internally developed NASA program or a commercial program. The ASAP has expressed this repeatedly to the Administrator and to Congress. This said, the ASAP's position and intent is to achieve well-defined programs that can be completed safely, executed efficiently, and that are in the Nation's best interest, in whatever direction the Administration chooses to go forward. If commercial providers are to be a key element of NASA's future, the Panel again points out that they must develop HRRs as quickly as possible.

SAFETY AND MISSION ASSURANCE (S&MA) OVERVIEW

Mr. John Frost reported on the overview that the ASAP received on S&MA. S&MA is the nexus of the culture of the organization. The ASAP has heard about the MSFC S&MA program three times since 2006. The program was sound then and it is even better now. Many of the elements being practiced at MSFC have been recommended for implementation at other Centers. The organizational structure of the S&MA Program is built around supporting the projects and programs that are the lifeblood of MSFC. Assignments are specifically aimed at Ares, Constellation, or Shuttle. A major shift in NASA's programs will challenge everything from mission functions, to organizational assignments, to funding, and there will be a seismic shift in the way that NASA does business. MSFC has been doing an excellent job in assessing organizational health, which is critical to understanding the safety culture. Mr. Frost also applauded the senior MSFC managers for recently taking on the challenge of having an accident-free organization. Lessons learned from this effort will be of great interest in the future

Mr. Frost discussed some organizational structure issues. Several years ago, there was an Agency-wide issue related to a comparable level of confidence and trust in the S&MA personnel capabilities as there was in the engineers. Since then, MSFC S&MA has done an excellent job of growing that respect and confidence. As an example, the grades between S&MA and engineering are all equivalent, and there is a healthy exchange of personnel between the two functions. S&MA is now considered an equal partner. Another S&MA issue relates the need for better safety and mission assurance tools. For years, the aerospace world has been using the same fault-tree analyses, risk matrix analyses, preliminary hazard analyses, etc., that were developed in the Apollo era. There has seldom been enough time or funds to develop new tools. Also, the organization is geared totally toward project support, leaving little time for tool development. If NASA's mission changes from real time project support to developing the technologies to go to Mars, it is important not to forget safety tool development, which must be part of that package. Mr. Frost suggested focusing efforts in this area.

S&MA TECHNICAL EXCELLENCE PROGRAM (STEP)

Ms. Deborah Grubbe addressed the STEP. NASA has an excellent process to improve the knowledge base and professionalism of the S&MA workforce as well as its entire workforce in the area of S&MA. The ASAP was impressed with the program that went from concept, to actual practice, to having over 700 graduates in STEP level 1 in one year. This was a great accomplishment. The graduates are relatively evenly divided between civil service and contractors. Since safety is a part of everyone's job at NASA, the STEP has applicability to all roles within the NASA organization. Ms. Grubbe recommended that the NASA Safety Center (NSC) continue to develop the remaining STEP levels (levels 2-4) for S&MA, and that the NSC, in the process of doing this development, take into account the changing nature of the S&MA roles within the new NASA organization; in essence, develop STEP for future roles, not past roles. Adm. Dyer recognized the contributions of Mr. John Marinaro, the Technical Excellence Director of the NSC, who has championed much of this work.

ENGINEERING DIRECTORATE TECHNICAL EXCELLENCE

On behalf of Dr. Bagian, Ms. Grubbe also reported on the Engineering Directorate Technical Excellence presentation and discussion. She agreed with Dr. Bagian's finding on the Engineering Directorate and how the engineering work and TA work are being done. Mr. Croomes gave a very clear briefing with great examples. MSFC has demonstrated a good understanding of Technical Excellence and TA, and the organization is applying it appropriately. The knowledge within Technical Engineering and TA will be a huge asset going forward.

CONSTELLATION PROGRAM LAUNCH VEHICLE RESPONSIBILITIES

Mr. Marshall reported on the fact finding and discussion concerning the Ares Program. The Program is in a transitional phase, and this was the focus of most of the ASAP's dialogue and discussion. Ms. Vanhooser, Acting Manager for the Ares Program, led an informative review of the Ares Program, starting with the fact that it is a Shuttle-derived launch vehicle for both low Earth orbit (LEO) and perhaps missions beyond. The ASAP talked about and reviewed some of the original designs from the Exploration Systems Architecture Study (ESAS) in 2005, the Systems Requirements Review (SRR) in 2006, the System Design Review in 2007, etc. They also talked about the successful Ares 1-X launch. The discussions led the ASAP to a number of issues that have been on the "risk table" for some time, e.g., thrust oscillation, single bulkhead risks, contact with the mobile launcher, etc. The general impression was that the MSFC staff continues to be at peak performance and are doing a superb job under the circumstances—continuing to find solutions, identify issues that need further reconciliation, etc. The ASAP was overwhelmed with the positive message. This program continues to have solid leadership and the right dynamics and focus. The risks will continue to be identified, at least for the next six months, and design and performance baselines will continue to mature. The ASAP encouraged the Program Manager and her staff to "keep the faith." There are lessons-learned that hopefully will be necessary in the future, and the Panel encouraged them to stay focused as they continue to serve the Nation.

With regard to thrust oscillation, there is a lesson to be learned. Thrust oscillation has been largely driven by exposure of the crew to certain vibration levels. More research is needed on what the acceptable vibration levels for the crew really are, whether they are on commercial launches or not. Related to that is the overall process issue of how to relate the crew's needs to the vehicle engineering needs and system design. Mr. Frost recommended that a more rigorous process of identifying and integrating the crew's desires into the system design would be worthwhile for the future.

ARIES 1-X

Mr. Frost summarized the presentation and the discussions on Ares 1-X. Ares 1-X was a very successful hardware demonstration and a validation of the math and physical models being used in the design. The ASAP reviewed a couple of issues that have been in the press. One was the tumble of the second stage, which was expected and part of the test. The fly-away maneuver performed as programmed and behaved as the models predicted. The ASAP also looked specifically at the parachute failure. The post-flight investigation has found the reason for the failure, and it appears a simple problem to fix. These are the lessons that are learned from test, and they are the reason for test. The ASAP saw nothing that was cause for concern and much that showed the new models are working well. These models can now be used in whatever direction NASA takes. As tools are improved, we can move ahead in many directions. The ASAP also looked at the DM-1 firing of the five segment first stage. Everything looked good there, and it behaved generally as expected.

COMMERCIAL TRANSPORTATION SERVICES UPDATE

Adm. Dyer noted that this was the most lengthy and dynamic portion of the meeting, dealing directly with the change in course between the Constellation Program and that which is detailed to some extent in the FY 2011 budget request. MSFC offered a wonderful graphic to focus the conversation—a jigsaw with a piece in each corner and a central piece—that showed the importance of an integrated approach to commercial cargo and crew. One corner of the puzzle is HRR, of which the ASAP has spoken much about. While it is true that NASA does have existing HRR, those requirements are written for NASA, not commercial providers. These requirements assume fifty years of foundational experience in a widely distributed body of knowledge. ASAP has been engaged for the last several meetings, including this one, on progress on what kind of HRR are necessary to provide commercial industry with an understanding of what is required to human rate a process for commercial transportation for NASA crew. Adm. Dyer drew an analogy with

building codes—it is one thing to write an electrical building code and provide it to an experienced electrician; however, if you are going to deliver a code to a less experienced person, then the delivery of knowledge must be more complete. There would be a need to speak with more clarity and be more comprehensive. There was some discussion about the importance of HRR, which is only one piece of the puzzle.

The second piece is NASA insight, and that relates to the knowledge. This balance of insight is all across the life cycle—from the very beginning through the end of the program. Another piece of the puzzle is the relationship with FAA. There is a great opportunity for interagency cooperation between NASA and FAA as we look at acquiring new space transportation capabilities and how to certify them.

The fourth corner of the puzzle is program requirements—relating to acquisition strategy, the interface with the crew, how to deal with emergency situations, loss of crew and loss of mission scenarios, how to train, the interfaces with government, etc. It all comes back to the need to put together all of the pieces to produce a process that will safely fly NASA astronauts and passengers on commercial vehicles.

The ASAP has talked about a couple of "catch-22's." Potentially, there are two of these going forward. Commercial industry claims to know how to build hardware and software quickly and cheaply, but to do so they must have great freedom of action and keep NASA at arms length. On other hand, NASA has deep knowledge built over many years on how to put humans into space which may be useful to commercial developers. NASA also has the requirement of communicating how they will certify the vehicle, and verifying how those bona fides of certification are accomplished. The question is: How does one do both? NASA may say to industry—you may have done it quick and cheap, but we cannot expose our astronauts to it because we have not had enough insight. Another end result to be avoided is where industry says it would have done it quicker and cheaper, but because of NASA's close involvement to gain insight, it couldn't do so. Neither represents an acceptable destination, and work needs to be done to avoid both.

There is a second catch-22. NASA knows much about how to put people in space, but has limited experience on the certification process, e.g., a process comparable to certifying airliners to carry passengers. The FAA knows much about certification because it is a regulatory agency, but it doesn't know a lot about crew safety for space flight, which is relatively new to FAA. It is important to work through this potential catch-22. What is needed is a clear understanding of the acquisition strategy, the necessary insight and oversight, and the necessary certification. Adm. Dyer talked about how to gain confidence to certify a new system going forward. It is possible to go forward with little oversight/insight, but there must be a very robust flight test and demonstration program to build enough confidence over history. On the other hand, if there is an intimate and extensive design understanding throughout all stages of development, then a more limited flight test program is possible. There are many points in-between.

Dr. Nield clarified that the opening discussion and the puzzle analogy was based on a presentation from a NASA Headquarters representative, rather than a MSFC representative.

Mr. Marshall shared his frustration with the HRR issue, which has been a long running, open ended item. Although the ASAP understands the complexity and difficulty of developing HR standards for the commercial realm, the ASAP is disappointed with the level of effort that NASA has thus far demonstrated. In this regard, the ASAP heard recently that there must be an acquisition strategy that parallels or precedes the standards. There is no question that an acquisition strategy is fundamental to the development of standards, but the ASAP noted that NASA should not stop or slow efforts to continue to develop the HR processes waiting on the new strategy. Not only are HR standards for a NASA-crewed commercial vehicle needed, but there is need for certification and verification to assure that the right level of standards are being achieved. There will be some who will fight that in the interest of faster, cheaper, better; however, the ASAP recommendation has been and continues to be that this entire certification and verification process is fundamental to NASA astronauts' safety.

Dr. McErlean noted that the graphic depiction was useful in illustrating that certification is a process, not a simple destination. The establishment of HR criteria is crucial, but it is only the beginning. Then one has to go through the process of assessing that the design meets criteria and that the designer has produced data

that validates that the criteria has been met. Then there is the in-plant process that shows that the hardware is being constructed in accordance with the validated design, and that the vehicle is being maintained and operated in accordance with the criteria, throughout the life cycle. This entire process spans the capability from first flight review all the way through flight and operation. The FAA provides a large body of certification law and regulation. In terms of ultimate protection for the passenger, e.g., for commercial airlines, there has been an outside assessment that the design is adequate, that it meets the criteria, that the design has been validated, the manufacturing process has been monitored, and that the device has been built, maintained, and operated in accordance with the criteria. Sometimes "human rating criteria" and "certification process" are used interchangeably. They are related, but they are not the same thing.

Ms. Grubbe noted that all of the changes in the FY 2011 budget are broader than HR, certification, and verification. The whole notion of what is NASA's work in S&MA is changing. S&MA should take a leadership role in beginning to analyze how their work is going to change for the future. A relevant question to pursue is: What kinds of skills are going to be needed in the future to ensure that the Nation's needs are effectively served?

Mr. Frost noted that the ASAP clearly heard that an acquisition strategy is needed first. If this is so (and the ASAP is not completely convinced that it is), then NASA should take action immediately to develop the acquisition strategy that will guide the development of the HR process. The ASAP continues its long standing recommendation that HR process for commercial sector is needed, and that it should be put on a fast track for completion.

Dr. Nield noted that the ASAP had excellent discussion on these very difficult issues. Congress has gone on the record as saying that HSF is inherently risky, and everyone needs to remember that. The general public should understand that HSF certification does not provide the same level of safety as airline certification. The discussion concerns the transport of NASA employees, as opposed to the FAA task that involves the public. Dr. McErlean added that there is a difference in the level of safety. Transportation in one of the most hostile environments known to man involves a risk level that is orders of magnitude higher than taking a flight to Denver.

Adm. Dyer noted that the ASAP is on record asking the question: How safe is safe enough? In its Annual Report, the ASAP has said that the answer to that question needs to be clearly communicated to the public, and the risk that the Nation is willing to accept going forward must be shouldered by NASA, Congress, and the White House.

NASA Headquarters has recently published a press report stating that before the end of 2010, there will be a promulgation of HRR for commercial activities. That schedule has some potential to put NASA behind rather than ahead. A more aggressive timeline needs to be developed for the development and publication of commercially related HRR.

Mr. Marshall added that he had been told that OMB is issuing direction and guidance to NASA to have a first formal cut at HRR by July 2010. That timeline does not include industry's comments, but the commercial office that is working this issue and is hoping to develop not only the initial cut but also obtain the industry reply. This is a good step forward.

Ms. Grubbe observed that one of the things learned at the meeting was the variety of work going on at MSFC. There is excellent work being done across the spectrum of Shuttle, ISS, and Constellation. With the changes going forward, NASA needs to begin now to document the tacit knowledge present in the heads of all the experts Agency-wide. This includes writing down and organizing the tacit knowledge that is not written down, organizing the explicit knowledge that is written down, and managing it all that so that nothing is lost. At some point in the future, this knowledge will become necessary. The purpose of the journey is to gain the knowledge to do more in the future. It will be a great loss if knowledge is not captured and managed. There have been good attempts, but they are disjointed. A more consistent, organized approach would be very beneficial. Mr. Marshall added that this topic has direct applicability to MSFC because MSFC is so good doing the research and the technology development. A user-friendly, well-understood, accessible, lessons-learned system is essential.

ARES 1 SAFETY PROCESS

Dr. McErlean discussed the safety process overview by the Ares Chief S&MA Officer (CSO), Mr. Chris Cianciola. He complimented the process, which can be applied to other projects and programs. Safety in the design started out in the basic architecture, e.g., the use of heritage equipment for Ares. The CSO made an excellent point--safety needs to be taken into account in the initial design, and S&MA needs to participate in all of the systems trades. For Ares, the robust abort capability, crew survival after abort, etc., was taken into consideration in the design and development of the vehicle. The project uses a risk-informed decision model. Risk drives resource allocation and design at each level. This approach gets the most "bang for the buck" in terms of making the system safer. The presentation included a discussion about the highly integrated processes and made the point that "successful implementation of this approach requires a thorough and accurate identification and characterization of the risk." The ASAP fully supports this principle. There was detailed analysis of loss of crew (LOC) and loss of mission (LOM), e.g., looking at failure modes analysis, secondary effects, etc. The focus on safety was excellent.

S&MA has been engaged in the program in a robust manner and has had an effect on the design. This is indicative of the quality of the MSFC S&MA. Sitting at the table as equals with engineering is the right approach. Customer feedbacks have shown that customers have a high opinion of S&MA credibility and want S&MA involved in the process. The ASAP talked with Mr. Cianciola about the safety and engineering review panels, and liked the idea that the MSFC and JSC Panel Chairmen serve as chairs on each others panels. This cross-organizational point of view is commendable. Overall, the Ares I safety process overview was very good. Dr. McErlean emphasized that the process that was put in place by the team could be applied to whatever program follows Ares, or even used in the evaluation of the commercial programs. It is important that safety be an integral part of the design process from inception. Where that hasn't been done, there will be increased challenge to ensure that proper safety considerations have been included.

Adm. Dyer noted that the next topic was an exception to Mr. Frost's observation about the lack of new tools in S&MA.

ABORT TRIGGERS AND EFFECTIVENESS

Ms. McDevitt noted that the work of Dr. Donovan Matthias at Ames Research Center (ARC), the ARC assistant manager for Ares vehicle integration, on abort triggers and their effectiveness is in support of the Constellation Program. The ASAP received an excellent review on the integrated risk assessment that is being done for Ares. This analysis is an advanced state of the art and quantitative engineering risk assessment incorporating, for example, physics-based scenarios and dynamic simulations, in order to come up with the likelihood of the different failure scenarios. It is an effort to look at the failure scenario, not in the traditional safety approach by looking at the causes and developing the mitigation plan, but looking at the initiating event and all of the paths of the outcome or consequences of the initiating event. The uncontained aspects of the consequences pose a threat to the crew and require development of the abort triggers. What has been done in this analysis is a complete mapping from the initiating scenario through the completion of the failure scenario in order to define the effect of the abort triggers that need to be in place to ensure that the crew can safely escape. It uses probabilistic risk assessment and dynamic scenarios in providing the most realistic representation of the failure. Very good work is being performed in this area.

After having reviewed this analysis, Ms. McDevitt had the following recommendation for the Agency: the integrated abort risk analysis and assessment are required for the proper design of crew survivable methods and present a challenge to vehicle providers who need to design for safe human flight. These triggers must be properly designed to provide for abort, and the timing of the triggers must ensure the safety of the crew. The ASAP feels that NASA needs to prescribe the methodology for performing such integrated abort risk analysis and develop the supporting tools as needed so that these types of analyses are performed uniformly

and consistently across the industry. This guidance could be developed as a stand alone document and referenced in their HR criteria. Industry as a whole could benefit from this. The launch vehicle providers are well-versed in the analyses and deliverables that are necessary in order to fly payloads, but there is still some way to go for them to fully understand what it takes to do a complex analysis like this.

Mr. Frost noted that one of the classic systems safety tools is the system safety hierarchy—it is best to design a hazard out; if that can't be done, then guard it out, and only if that can't be done, then rely on warnings or training. There is a new ANSI standard (ANSI/GEIA-STD-0010) that modifies this safety hierarchy somewhat. It adds a new step--active safety devices or Engineered Safety Features (ESF) which enhance safety by actively responding to a malfunction—which is what the abort triggering system is. This started in the nuclear industry with emergency cooling pumps, and has gained traction as a great way to handle hazards. He encouraged NASA to think of this as a new tool and the Ares integrated approach is an excellent implementation.

CONSTELLATION LAUNCH ABORT SYSTEM

Dr. McErlean discussed the overview that the ASAP received on the current Constellation launch abort system. It meets the definition of robust. There are no zones in the ascent in which there is no abort mode. There was only one place when the estimated probability of success went much below about 90 percent and that point is being worked on. Given the overall hazards of the ascent, this is a commendable abort system. There is good understanding of the integrated system, who does what, and when the decision is made. The presentation included a discussion of the 45th Space Wing debris assessment and noted the reasons for the potential differences between that assessment and the integrated risk assessment. It also included the plan for setting up the downrange abort zones so that the exclusion zones are avoided. The ASAP came away with the impression that the launch abort system is quite a robust system. The process by which the system was designed, the steps that were taken in terms of designing it, the shared responsibilities, determining what system recommends abort, what system takes action, is very good. Although the individual steps may be different, the process appears capable of being carried over into any future transportation system. The ASAP complimented the team for good analysis, solid thinking, and a robust system. Dr. McErlean emphasized that the lessons-learned from developing this system are solid pieces of information, and they need to be codified so that they are not lost.

EVALUATION OF THE CHALLENGES OF HUMAN RATING ARES V

Mr. Marshal reported on the presentation on Ares V. He noted that was a very interesting subject and spurred discussion among the Panel members. Ares V is in pre-phase A conceptual design. The presenter, Ms. Sherry Jennings, talked about the concepts and requirements for human rating Ares V. Currently, there is no mission requirement for Ares V to be human rated during the ascent phase. That may change, and consequently the project is willing to preserve the options to integrate HR at a future date. For on-orbit missions involving the crew, there is a need to have a HRR that should be integrated from the beginning. The discussion included the subject of failure tolerances and design for minimum risk, ascent induced environments, etc. The only issue came from discussion of the following questions: What is the requirement? Are you over-designing or preserving options for a later stage? It is important to integrate safety at the very beginning and the ASAP applauds this approach; however, it is also important to codify and formalize the requirements at the right time to avoid either overdesign or the opposite.

SCIENCE AND MISSION SYSTEMS RESPONSIBILITIES FOR ISS

Dr. Nield reported on the briefing and discussion on science and mission systems responsibilities for ISS. The ASAP looked into the types of support MSFC is providing to the ISS. There are a number of different focus areas, including the Environmental Control and Life Support System (ECLSS) support to the ISS vehicle office and the payloads operations support to the payloads office. The kind of support ranges from project management support to a wide variety of engineering expertise. The work to date has been very

successful and very much appreciated by the ISS Program. Since the ISS construction is essentially complete, the majority of the work going forward will be related to sustaining engineering and anomaly resolution.

INDUSTRIAL SAFETY INITIATIVES AND PROACTIVE APPROACHES

Ms. McDevitt reported on the presentation on the Industrial Safety Program that the ASAP received from Mr. Edward Kiessling, manager of MSFC's S&MA Safety, Quality, and Management Systems Department. He reviewed the metrics for 2009, including the lagging and leading indicators. Several items have been used as leading indicators, and all of these areas, with one or two exceptions, were shown as "green" – suggesting that, in light of the Center's initiative to have zero mishaps, the set needs to be broadened to effect still greater improvement in what is already a world class industrial safety program. The Center uses the world class thresholds as its goals and all of the metrics data shows that MSFC is at or under the thresholds. In looking at the leading indicators and efforts that one considers putting into place in order to improve, she suggested that it might be worthwhile for MSFC to spend some time looking at indicators that other industries and organizations are using, specifically the chemical process industry. Ms. McDevitt commended MSFC for having and maintaining a world class safety organization.

The MSFC S&MA people are very excited about the Center Director's initiative to pursue a zero injury and incident rate for MSFC. In order to achieve that, MSFC is undertaking a culture transformation. Instead of concentrating only on a mishap rate, they are looking beyond that to the effect a mishap has or could have on a person—their family, their co-workers, etc. It is an exciting new initiative, and MSFC is to be commended for always looking forward. Ms. Grubbe offered a cautionary note—one potential unintended consequence of the zero incident/injury goal could be a reluctance in reporting incidents, and MSFC needs to watch for that.

Dr. McErlean added that MSFC is constructing new engineering staff buildings, which goes a long way to improving the sense that what people are doing is important. He complimented the Center leadership in getting construction funds to upgrade facilities for the workforce. Indirectly, this relates to safety—people have a better overall view of their entire working environment.

Adm. Dyer noted that he was particularly impressed with how MSFC is addressing the vibration and oscillation issues with Ares I, which has been reported in the press. The MSFC team attacked that issue and developed an innovative approach using liquid oxygen and bellows at cryogenic temperatures to solve a problem. He was especially impressed that MSFC attacked the problem starting with the physics aspect—gaining an understanding of the phenomenon—to doing modeling and simulations, to doing rapid prototyping. They went from a technology readiness level (TRL) 1 to 5 in about 10 months.

Mr. Frost added that the benefits of this technology development go far beyond NASA's immediate operations, e.g., for helicopters and seismic protection of buildings. The ASAP was very impressed.

In response to Adm. Dyers request for any other comments, Dr. McErlean noted that the collaborative engineering facility is another great idea. MSFC is on the leading edge of this application, which is very powerful and a great investment.

CONCLUDING REMARKS

Adm. Dyer stated that MSFC is a national treasure. The ASAP always enjoys its time here and always comes away impressed with the Center's spirit, energy, focus, and innovation, which is unabated even in these dynamic and trying times. He again expressed the Panel's appreciation for the excellent presentations from and stimulating discussions with MSFC staff.

Questions or comments were invited from the audience, but there were none. The meeting was adjourned at 2:10 pm.